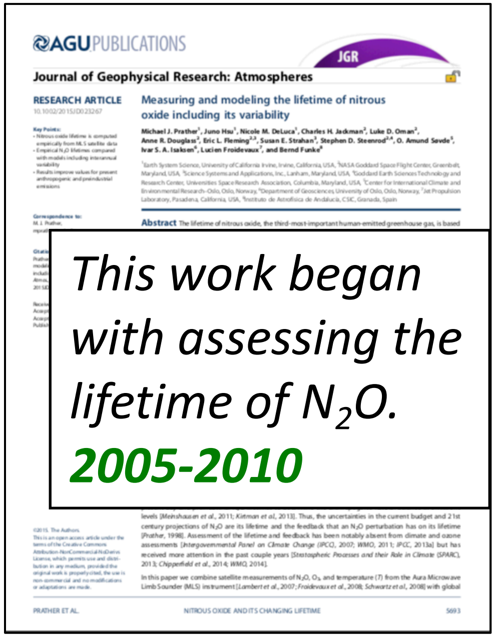
Using Aura MLS observations to model budget terms, strat-trop fluxes, and surface variability of N_2O

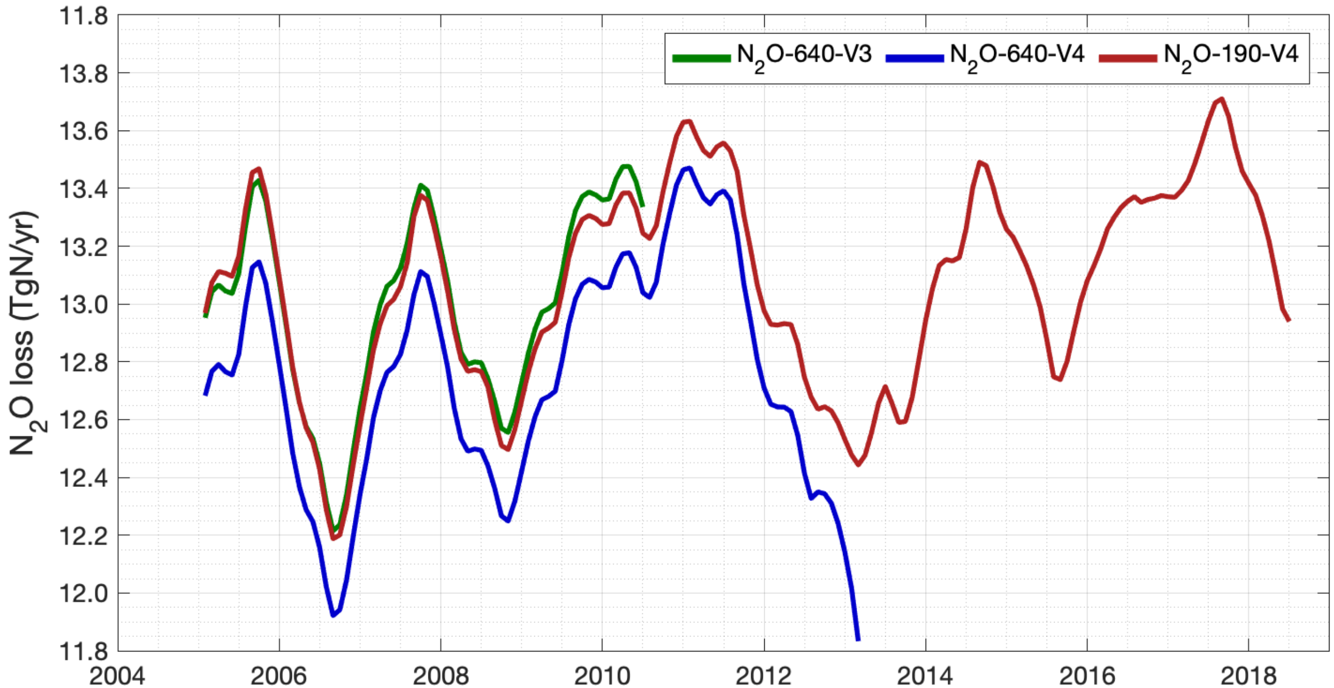
Daniel Ruiz & Michael Prather,

Earth System Science Dept, UC Irvine

N_2O loss from Aura MLS measurements



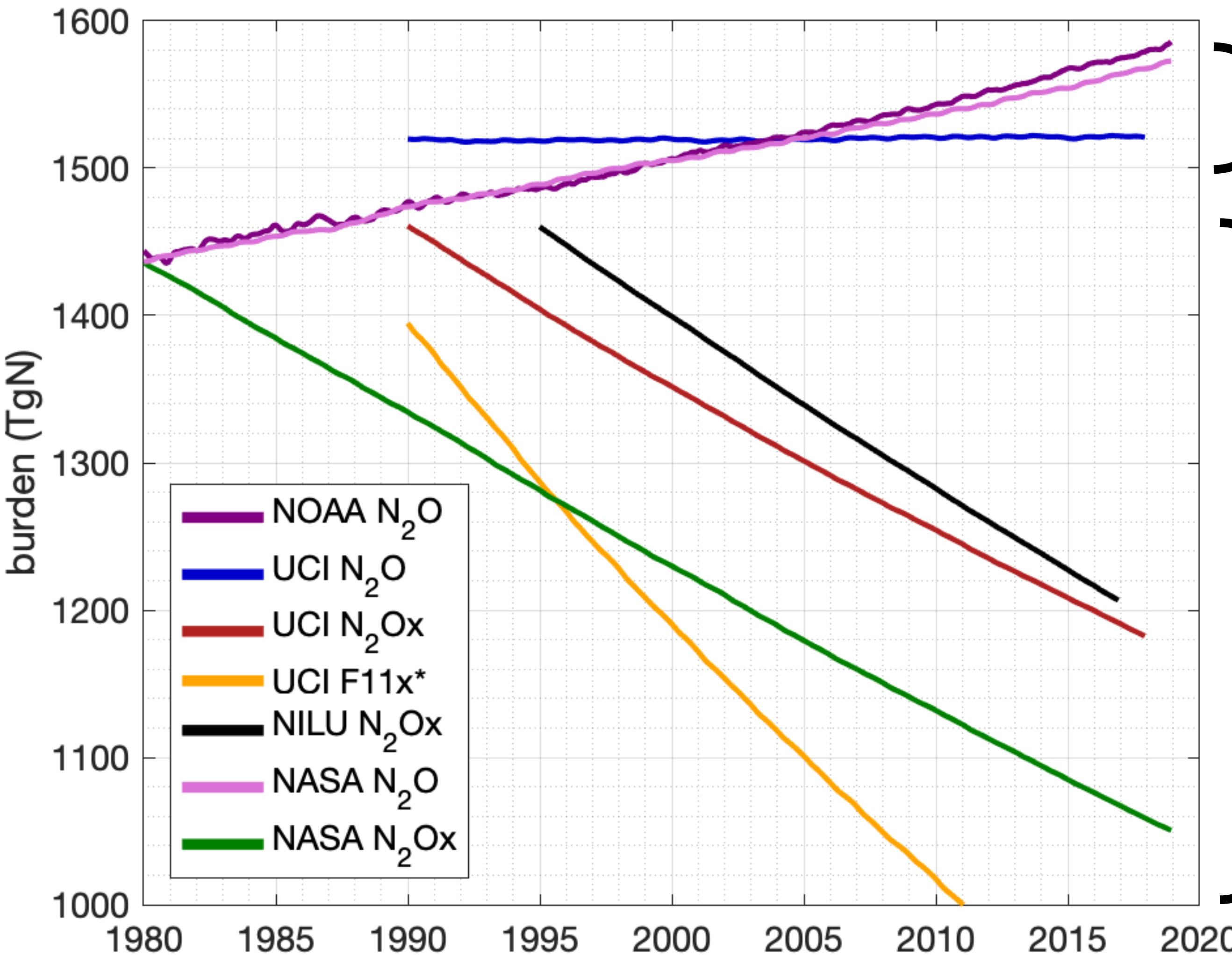
This work began with assessing the lifetime of N_2O.
2005-2010



Identifier	Version	Spectral Region	Availability	Comments
N2O-640-V3	V3.3	640 GHz	08/2004-12/2010	Prather et al. 2015
N2O-640-V4	V4.2x	640 GHz	08/2004-12/2013	MLS instrument issue; channel data not recommended after 07/2013
N2O-190-V4	V4.2x	190 GHz	08/2004-12/2018	Retrieval bias for profiles >68 hPa, not used

N_2O – MIP (UCI CTM, NASA GMI, NILU LMDZ5)

Decay per N-tracers are simulated in the absence of surface emissions to preserve the stratospheric signal

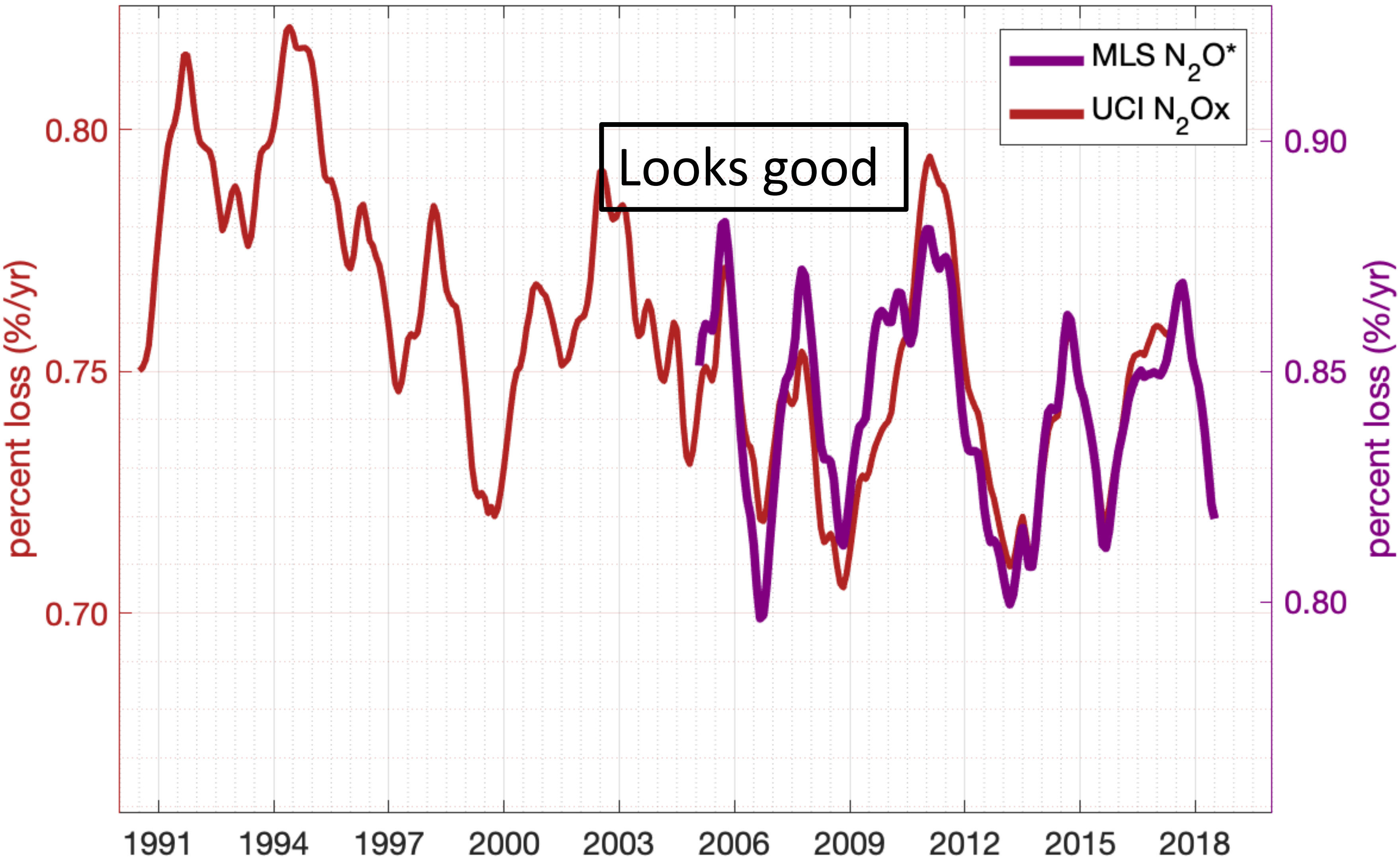


N_2O (emissions)

N_2Ox (no emissions)

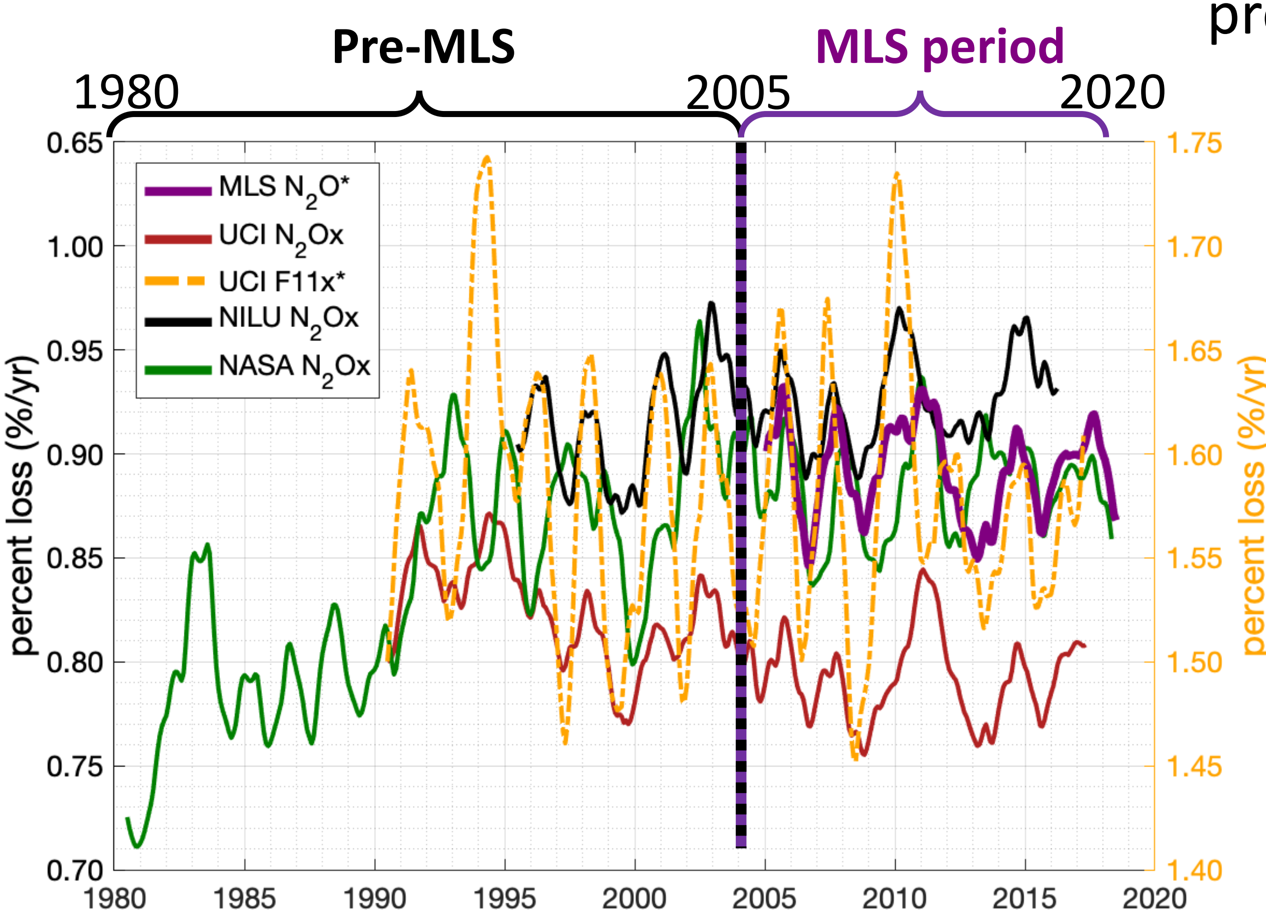
UCI F11x* is treated as N_2Ox with CFC-11 decay rate

Measurements vs Models



MLS N_2O^* uses NOAA HATS N_2O burden for 2005-2018 (ppb)

Measurements vs Models



Was N_2O loss different pre-MLS? **Yes**

MLS overlap period	Mean Loss	Mean LT
UCI N_2Ox	0.74%/yr	135 yrs
UCI F11x	1.58%/yr	63 yrs
MLS N_2O	0.84%/yr	119 yrs
NILU N_2Ox	0.88%/yr	114 yrs
NASA N_2Ox	0.80%/yr	125 yrs

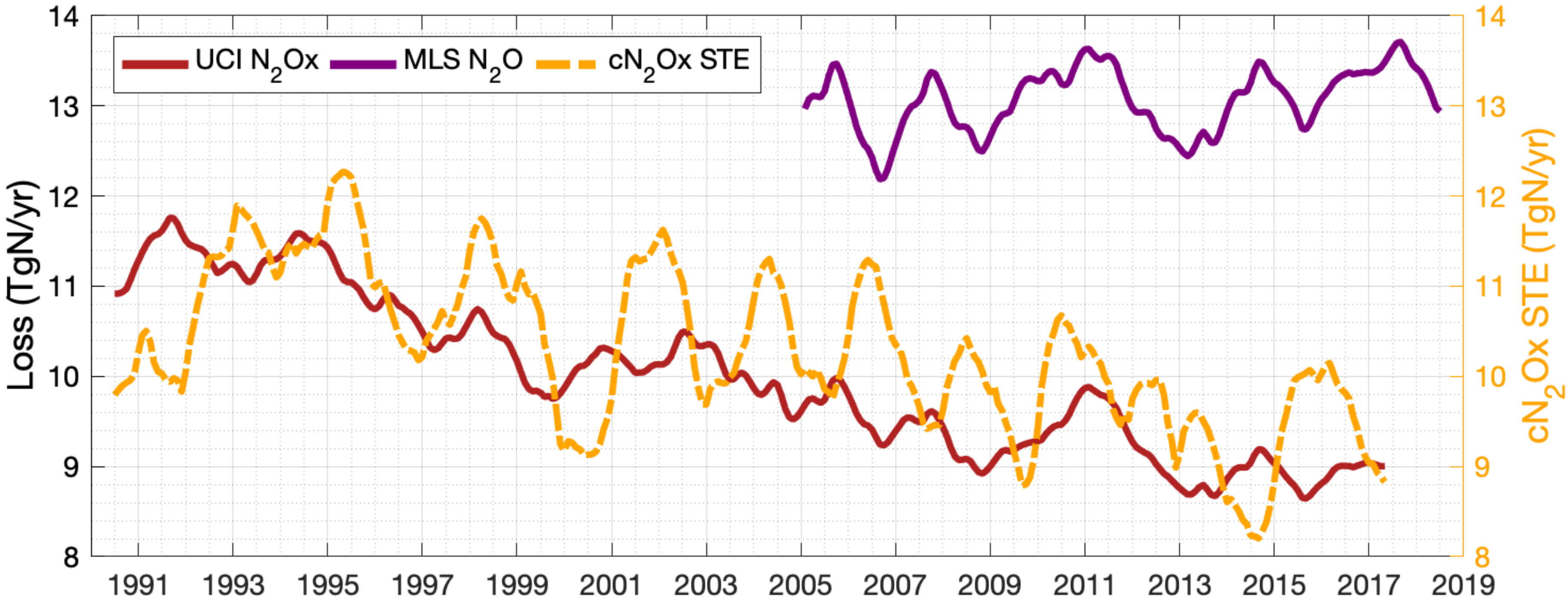
Entire period	Mean Loss	Mean LT
UCI N_2Ox	0.76%/yr	132 yrs
UCI F11x	1.58%/yr	63 yrs
NILU N_2Ox	0.87%/yr	115 yrs
NASA N_2Ox	0.83%/yr	120 yrs

MLS N_2O* uses NOAA HATS N_2O burden for 2005-2018 (ppb)

UCI F11x* decay corresponds to the right axis. All others correspond to the left.

Complementary N2O (Neg-N2O) flux vs N2O(x) loss

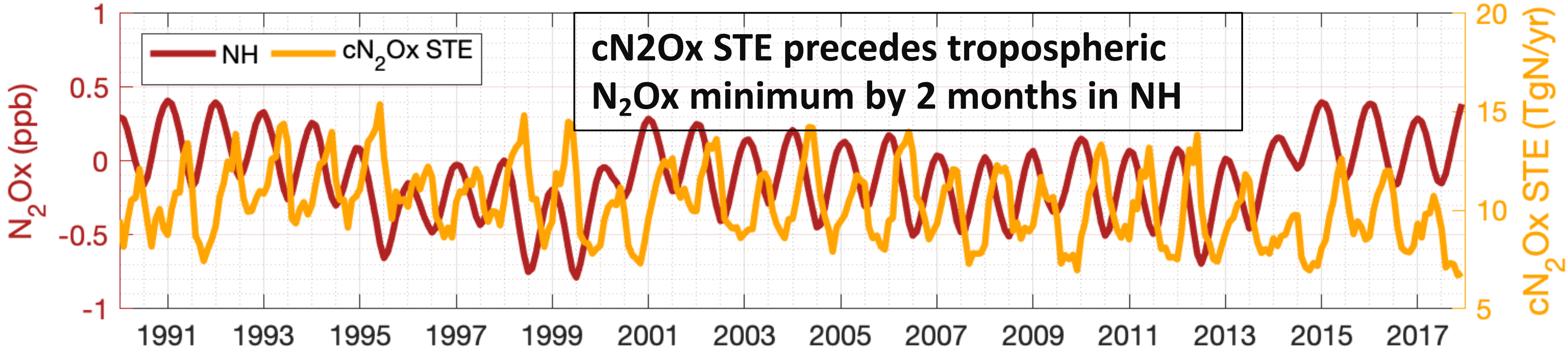
Stratospheric N_2O loss leads to peak neg-N_2O flux ~1 year later

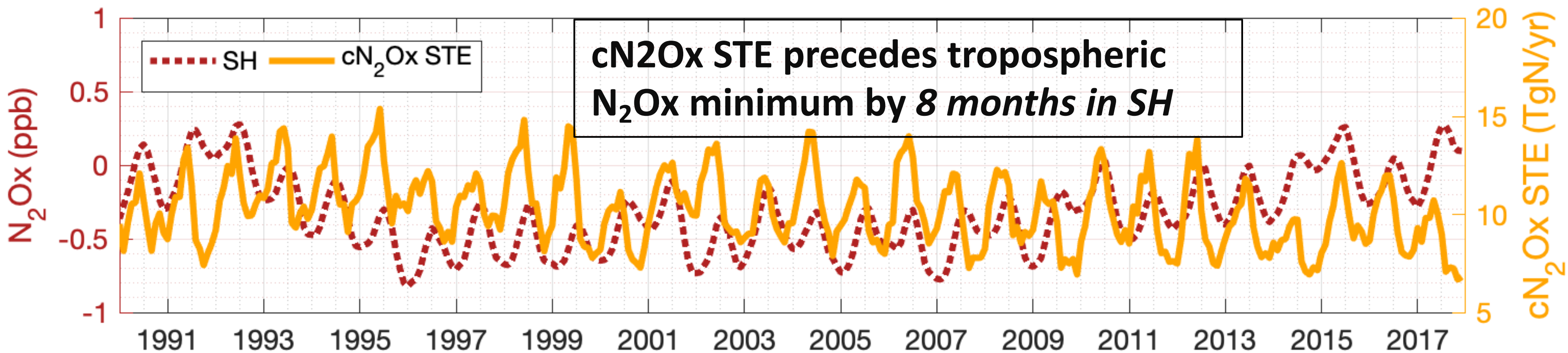


X-correlation w/ cN2Ox STE	Offset
MLS N2O loss	-1.0 yrs
UCI N2Ox loss (MLS overlap period)	-0.9 yrs
UCI N2Ox loss (entire period)	-1.0 yrs

cN_2Ox: every N_2Ox molecule lost produces one cN2Ox molecule

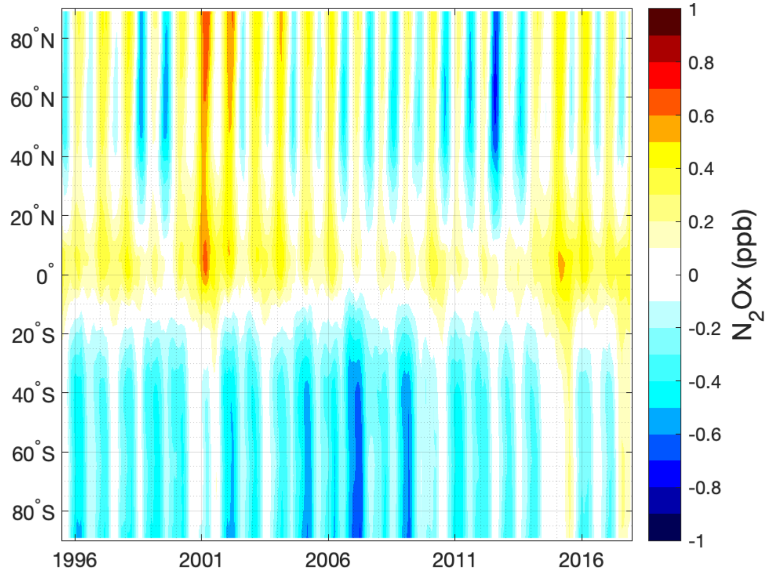
Monthly Tropospheric N2Ox vs total cN2Ox STE flux





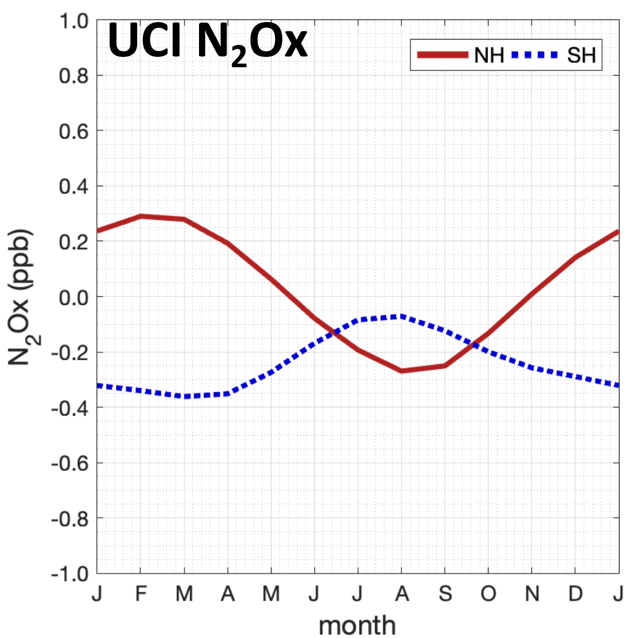
X-correlation w/ cN2Ox STE	Offset
UCI N2Ox Northern Hemisphere	+0.2 yrs
UCI N2Ox Southern Hemisphere	+0.7 yrs

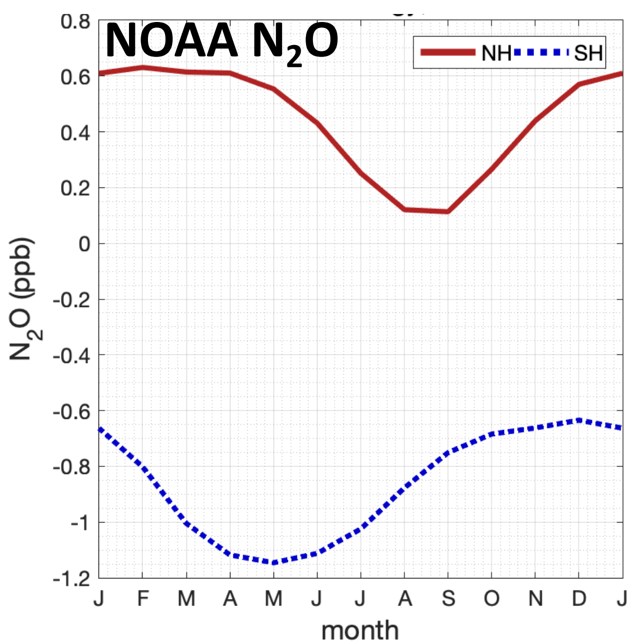
Surface N_2Ox: Seasonal cycle of stratospheric loss



- **North** Larger seasonal amplitude
- **South < North**

Monthly surface climatologies

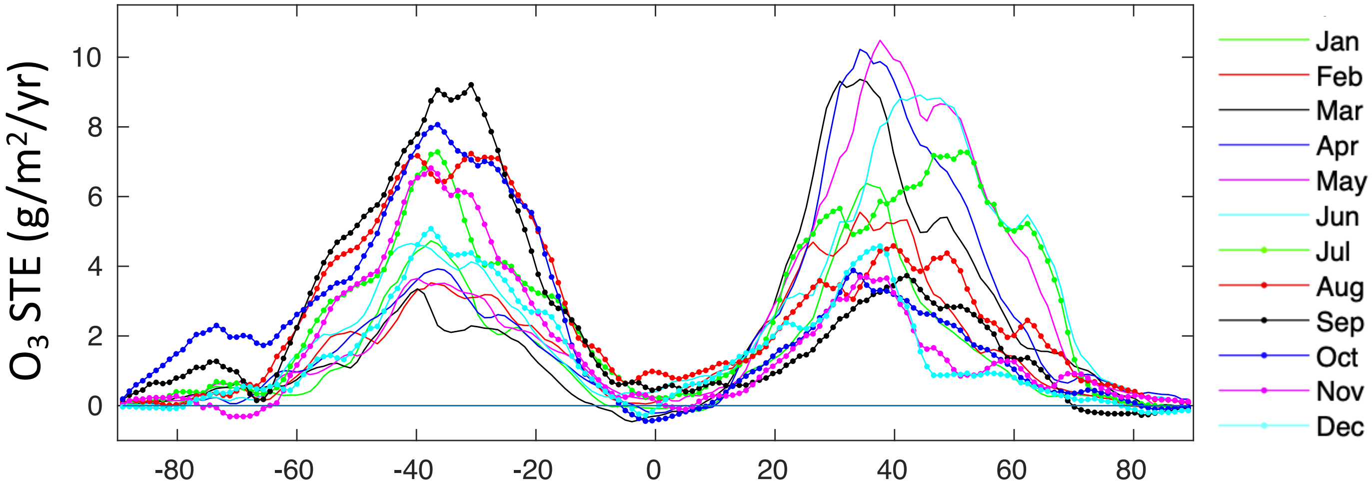




UCI N_2Ox (no emissions) agrees with NOAA NH seasonal cycle

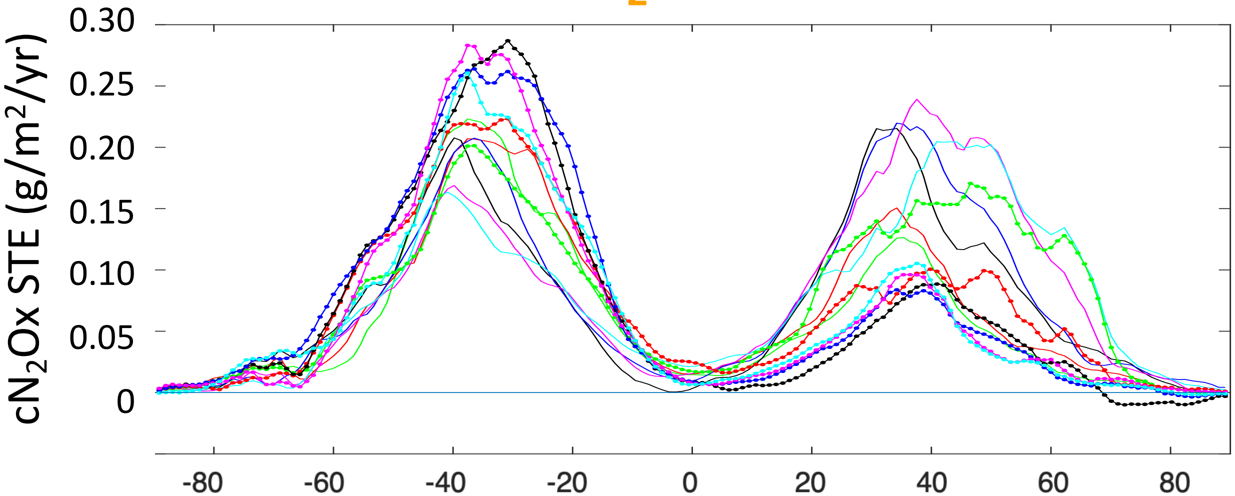
UCI CTM STE: How do the STE fluxes compare in each hemisphere?

O_3 STE



Annual **O_3 STE** is symmetrical

cN_2Ox STE

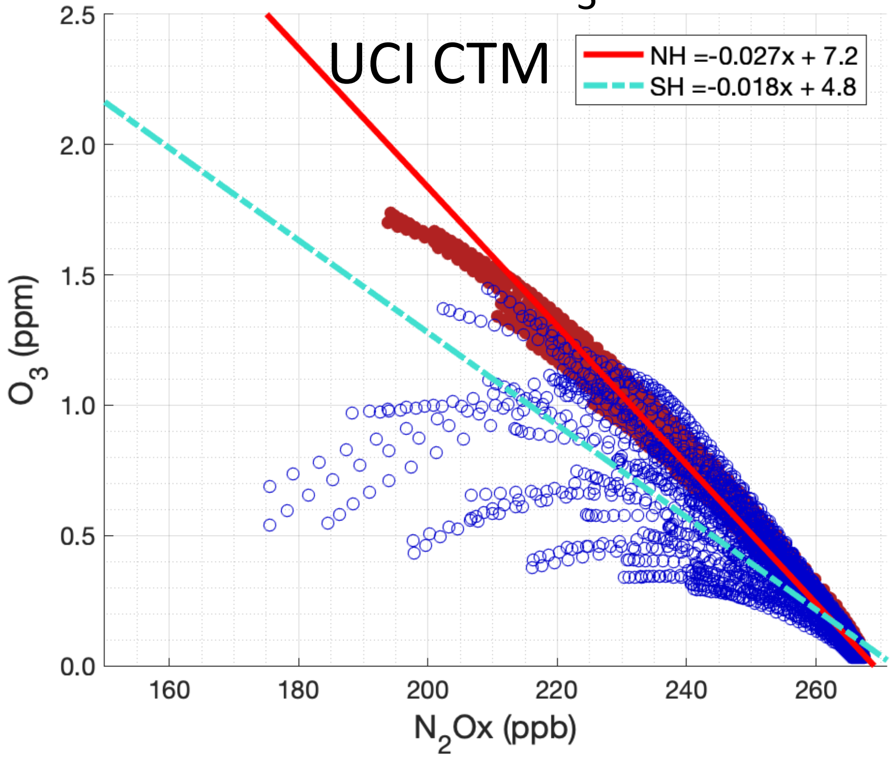


STE Flux	O3 (Tg/yr)	cN2Ox (Tg/yr)
Total	349	11.2
NH	185	4.6
SH	164	6.6
S:N Ratio	0.9	1.4

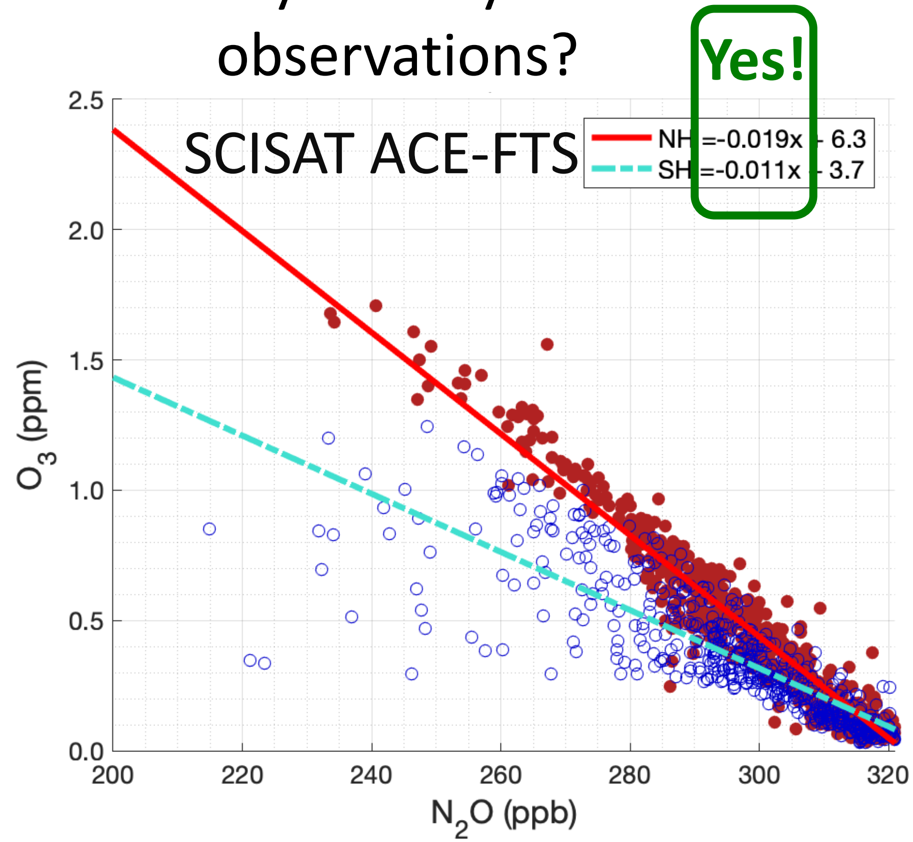
negative-N_2O STE SH > NH (mechanism not understood)

N_2O vs O_3 Tracer Correlations:

Lower N_2Ox (no emissions) in SH for same O_3



Do we see hemispheric asymmetry in observations?



- Hemispheric difference due to increased transport of depleted-N_2O air into SH?

*Data > 70° were not used due to retrieval limitations of ACE orbit

Acknowledgements

- Jet Propulsion Laboratory – Lucien Froidevaux
- GSFC – Susan Strahan, Steve Steenrod
- NILU – Rona Thompson
- NOAA – James Elkins, Geoff Dutton
- NASA – Ken Jucks